Interchange reconnection within coronal holes powers the fast solar wind

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The fast solar wind that fills the heliosphere originates from deep within regions of open magnetic field on the Sun called 'coronal holes'. However the energy source responsible for accelerating the outflowing plasma to such high speeds is still widely debated, although there is broad evidence that it is ultimately magnetic in nature with candidate mechanisms including Alfven wave heating[1,2] and interchange reconnection[3,4]. The magnetic field near the solar surface within coronal holes is structured on spatial scales associated with the boundaries of meso-scale supergranulation convection cells, where descending flows create intense bundles of magnetic field. The energy density in these 'network' magnetic field bundles is a likely candidate as an energy source of the wind. Here we report measurements of two fast solar wind streams from the Parker Solar Probe (PSP) spacecraft[5] near its 10th perihelion which provides strong evidence for the interchange reconnection mechanism. Specifically, we show that supergranulation structure at the coronal hole base remains imprinted in the near-Sun solar wind resulting in asymmetric patches of magnetic ``switchbacks''[6,7] and bursty solar wind streams with corresponding energetic ions with power law-like distributions extending to beyond 100 keV. Particle-in-cell simulations of interchange reconnection between open and closed magnetic structures support key features of the observations, including the energetic ion spectra. Important characteristics of interchange reconnection in the low corona are inferred from the PSP data including that the reconnection is collisionless and that the rate of energy release is sufficient to heat the ambient plasma and drive the fast wind. In this reconnection scenario of solar wind energization, open magnetic flux undergoes continuous reconnection and the wind is driven both by the resulting plasma pressure and the radial Alfvenic flow bursts.